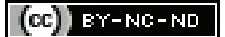


# Role of Magnetic Resonance Cholangiopancreatography and Ultrasound as a Diagnostic Tool in Suspected Cases of Biliary Obstruction: A Prospective Cohort Study

ABHINESH SARAF<sup>1</sup>, SWAPNIL PURANIK<sup>2</sup>, MONIKA PURANIK<sup>3</sup>

## ABSTRACT

**Introduction:** Obstructive jaundice is a common and grave form of hepatobiliary disease. It can pose problems in diagnosis and management, particularly intrahepatic cholestasis. Magnetic Resonance Cholangiopancreatography (MRCP) and Ultrasound (USG) are the frontline modality for biliary and pancreatic duct imaging.

**Aim:** To evaluate the accuracy of USG and MRCP in assessing the level and cause of biliary obstruction which were compared with pathological or surgical findings.

**Materials and Methods:** This prospective cohort study was conducted in the Department of Radiodiagnosis in a tertiary care hospital from August 2013 to August 2015. Total 60 patients who were referred from the Department of Surgery and Medicine with strong clinical suspicion of biliary obstruction and altered Liver Function Test (LFT) were included in the study. All these patients underwent USG examination within a day of MRCP. Patients with previous biliary surgery and in whom Magnetic Resonance Imaging (MRI) was contraindicated were excluded. As a gold standard, the authors used ERCP, histological test

and pathological findings after surgical intervention. The data collected was statistically analysed; sensitivity and specificity were calculated by using true and false positive and/or negative fractions.

**Results:** The majority of patients were females and in sixth decade of life. The diagnostic accuracy of USG in detecting level of obstruction was comparable with MRCP. USG was 100% accurate in detecting hilar and suprapancreatic obstructions. In infrapancreatic obstructions diagnostic accuracy of USG was 95% as pancreatic head and peripancreatic region are poorly visualised on ultrasonography due to bowel gas shadows. Diagnostic accuracy of USG in the present study was 98.3%, one false negative case was of a small, soft, 4 mm calculus in distal Common Bile Duct (CBD). Sensitivity and specificity of USG in differentiating cystic from solid masses was 100%.

**Conclusion:** The USG with improved technology and operator experience should be considered as the first choice in the diagnostic imaging of obstructive biliary disease. If the suspicion posed by clinical and laboratory findings are not confirmed at USG, the diagnosis must be achieved with the aid of MRCP.

**Keywords:** Bile duct, Hepatic cholestasis, Hepatobiliary disease, Magnetic resonance imaging, Pancreatic duct

## INTRODUCTION

Despite the technical advances, the operative modes of management of obstructive jaundice were associated with very high morbidity and mortality [1,2]. The expanding spectrum of therapeutic options for the jaundiced patient has made it necessary for the radiologist to do more than simply discriminating between obstructive and non obstructive jaundice [3]. The MRCP is the newest modality for biliary and pancreatic duct imaging. It represents the most popular current clinical application of Magnetic Resonance (MR) hydrography (i.e., MR imaging of fluid) [4]. The MRCP uses MR imaging to visualise fluid in the biliary and pancreatic ducts, as, long T2 value of fluid allows ducts to be imaged in their basal state without distension by exogenous contrast [5,6]. A lot of work has been done in the past for the comparison of sensitivity and specificity of various modalities and these studies showed wide range of variation in diagnostic ability of USG for obstructive jaundice i.e., from 41-89%, while in MRCP it is approximately 95% for level and 87% for cause [7-10]. The authors observed that most of these studies did not specify whether they were done by radiologists experienced in biliary scanning. Most of these studies were performed with older equipment.

In the present study, we tried to evaluate the accuracy of USG and MRCP in suspected case of biliary obstruction under the light of

new technologies of USG and experienced sonologist and thus finally we tried to evaluate accuracy of USG and MRCP in assessing the level and cause of biliary obstruction.

## MATERIALS AND METHODS

This prospective cohort study was conducted in Department of Radiodiagnosis, People's College of Medical Sciences and Research Centre, Bhopal, Madhya Pradesh, India, a tertiary care hospital from August 2013 to August 2015.

**Inclusion criteria:** Total 60 patients were included who were referred from Department of Surgery and Medicine with strong clinical suspicion of biliary obstruction and altered LFT. All these patients underwent USG examination within a day of MRCP.

**Exclusion criteria:** All the patients in whom MRI was contraindicated and patients with history of previous biliary surgery were excluded. Patients suspected or known to have pancreatic disease, rapid or irregular respiratory pattern due to liver failure with tense ascites, pregnancy and renal insufficiency were also excluded.

## Study Procedure

All patients included were subjected to detailed clinical history and general physical examination. Laboratory examination including

haemogram, LFT and coagulation profile was done followed by imaging of biliary system.

## Ultrasound (USG)

Ultrasound examinations of the liver were performed on Philips iU-22 machine and Wipro GE using 3-5 MHz abdominal transducer and 9-12 MHz linear transducer where required. Acoustic gel was used for skin-transducer coupling. Detailed examination of the liver, gall bladder, biliary radicals, pancreas and adjacent organs was carried out. Patients were examined preferably after a fasting period of minimum six hours to promote gastric emptying and filling of gall bladder. The two major views employed were the parasagittal and subcostal oblique. Further views were taken as necessary.

## MRCP Equipment and Technique

The study was carried out on a 1.5 Tesla whole body MRI system (Siemens Magnetom Symphony TIM Technology 18 Channel, Germany). All patients were subjected to a detailed MR examination. The patient was placed on the MR table in supine position with arms placed above the head. Patient was explained to stay still and avoid movements. In cases where the patient was irritable and anxious, sedatives were used. The T2 weighted axial images, Half Fourier Single Shot Turbo Spin Echo (HASTE) were obtained by using a Single-Shot Fast Spin Echo (SSFSE) sequence, T1 weighted flash images, MRCP thick slabs were performed using SSFSE inversion Recovery (SSFSE-IR) sequence and thin slice acquisition in coronal oblique or true coronal planes were acquired using SSFSE.

Postprocessing of the source images was obtained by using maximum intensity projection and multiplanar reformation algorithms. The source images and their reconstruction were viewed by the radiologists to ensure that the images were of diagnostic quality and that the anatomy was adequately covered. The MRCP findings were studied by other radiologists, who were experienced in MR/Computed Tomography (CT) imaging for more than nine years.

The USG findings and MRCP were read by radiologist blinded to the other imaging findings and recorded on prescribed proforma. As gold standard we used ERCP, histological test and pathological findings after surgical intervention, in accordance with the appropriate diagnostic and therapeutic approach to the case considered.

## STATISTICAL ANALYSIS

The data collected was statistically analysed using MedCalc software version 20.019; sensitivity and specificity were calculated by using true and false positive and/or negative fractions.

## RESULTS

Maximum number of the patients in the present study belonged to age group 61-70 years (31.7%) followed by age group 31-40 years (18.3%) and 41-50 years (18.3%) [Table/Fig-1]. Females were 37 (61.7%) and males were 23 (38.3%) in number.

Age (Years)	No. of patients (N)	Percentage (%)
≤20	2	3.3
21-30	2	3.3
31-40	11	18.3
41-50	11	18.3
51-60	6	10
61-70	19	31.7
≥71	9	15
Total	60	100

[Table/Fig-1]: Age wise distribution of cases.

Jaundice (60%) was the most common presenting clinical findings followed by pain in abdomen (48%) [Table/Fig-2].

Clinical features	No. of patients (n)	Percentage %
Jaundice	36	60
Pain in abdomen	29	48
Pruritis	13	22
Fever with chills	6	10
Anorexia and weight loss	10	17

[Table/Fig-2]: Distribution of the patients on the basis of clinical presentation.

Most common benign condition of biliary obstruction in the present study was choledocholithiasis (25 patients) while gall bladder carcinoma was most common malignant cause of biliary obstruction (10 patients) [Table/Fig-3].

Pathology	USG	MRCP	Final diagnosis	
Benign disease	Choledocholithiasis	24	25	25
	Benign stricture	4	5	5
	Choledochal cyst	3	3	3
	Mirrizi's disease	1	1	1
Malignant disease	Cholangiocarcinoma	7	7	7
	Periampullary carcinoma	8	8	8
	Gallbladder carcinoma	9	10	10
	Carcinoma pancreas	1	1	1

[Table/Fig-3]: Distribution of the cases on the basis of cause of obstruction on USG, MRCP and final diagnosis.

Sensitivity (SE), Specificity (SP), Diagnostic Accuracy (DA) of USG in diagnosing choledocholithiasis were 96%, 100% and 98.3%, respectively [Table/Fig-4]. Total number of cases of calculus disease was 25. Out of 25 cases, 19 patients had both Gall Bladder (GB) and CBD calculus, six patients had only CBD calculus. The accuracy for diagnosing GB calculus by USG and MRCP was 100%, that for CBD calculus by USG was 98.3% and by MRCP was 100%.

Pathology	TP	FP	FN	TN	SE	SP	DA
Benign disease	Choledocholithiasis	24	0	1	35	96	98.3
	Benign stricture	3	1	2	54	60	95.1
	Choledochal cyst	3	0	0	57	100	100
	Mirrizi's disease	1	0	0	59	100	100
Malignant disease	Cholangiocarcinoma	7	0	0	53	100	100
	Periampullary carcinoma	8	0	0	52	100	100
	GB carcinoma	9	0	1	50	90	98.3
	Carcinoma pancreas	1	0	0	59	100	100

[Table/Fig-4]: Sensitivity, specificity and diagnostic accuracy of USG for different pathological condition.

TP: True positive; FP: False positive; FN: False negative; TN: True negative

Diagnostic accuracy of MRCP for diagnosing periampullary carcinoma was 100%. The MRCP shows 100% DA in rest of the diseases [Table/Fig-5].

Pathology	TP	FP	FN	TN	SE	SP	DA
Benign disease	Choledocholithiasis	25	0	0	35	100	100
	Benign stricture	5	0	0	55	100	100
	Choledochal cyst	3	0	0	57	100	100
	Mirrizi's disease	1	0	0	59	100	100
Malignant disease	Cholangiocarcinoma	7	0	0	53	100	100
	Periampullary carcinoma	8	0	0	52	100	100
	GB carcinoma	10	0	0	50	100	100
	Carcinoma pancreas	1	0	0	59	100	100

[Table/Fig-5]: Sensitivity, specificity and diagnostic accuracy of MRCP for different pathological condition.

Ultrasound was 100% accurate in detecting hilar and suprapancreatic obstructions. In infrapancreatic obstructions, diagnostic accuracy

of USG was 95% as pancreatic head and peripancreatic region are poorly visualised on ultrasonography due to bowel gas shadows [Table/Fig-6]. The MRCP was 100% accurate in detecting hilar, suprapancreatic and infrapancreatic obstructions [Table/Fig-7].

USG	TP	FP	FN	TN	SE	SP	DA
Hilar	11	0	0	49	100	100	100
Suprapancreatic	14	0	0	46	100	100	100
Infrapancreatic	32	0	3	25	91.43	100	95

**[Table/Fig-6]:** Sensitivity, specificity and diagnostic accuracy of USG in diagnosing level of obstruction.

MRCP	TP	FP	FN	TN	SE	SP	DA
Hilar	11	0	0	49	100	100	100
Suprapancreatic	14	0	0	46	100	100	100
Infrapancreatic	35	0	0	25	100	100	100

**[Table/Fig-7]:** Sensitivity (SE), Specificity (SP) and Diagnostic Accuracy (DA) of MRCP in diagnosing level of obstruction.

## DISCUSSION

Today many imaging modalities are available for the evaluation of patients with suspected biliary obstruction including USG, computed tomography and invasive cholangiography. The MRCP is a relatively new technique, which has gained popularity because of its excellent diagnostic capabilities in the evaluation of biliary obstruction. USG and MRCP are two non invasive and non radiation modalities for evaluation of biliary and pancreatic pathology [11].

Females constituted majority of patients in the present study (61.7%) which is in conformity with the results of Chalya PL et al., [11]. Female preponderance in both benign and malignant obstructive jaundice has been ascribed to high prevalence of gall stone in them which is reported to be a risk factor for causing biliary obstruction.

The opinion is broadly shared that USG is the first-choice in the diagnosis of choledocholithiasis. Sensitivity, specificity and diagnostic accuracy of USG in diagnosing choledocholithiasis was 96%, 100% and 98.3%, respectively. The present study results for USG in diagnostic accuracy, sensitivity and specificity are in accordance with those reported in the paper by Boraschi P et al., and Singh A et al., [12,13]. The authors' diagnostic accuracy and sensitivity were higher than the values documented by Varghese JC et al., (2000) [14].

The high sensitivity in the present case series presumably derives from the considerable experience of the sonologist's, to the use of graded compression, and to Tissue Harmonic Imaging (THI), which allowed for better study of the distal tract of the CBD. Ortega D et al., described about harmonic imaging which improves contrast resolution, stresses the difference between the anechoicity of the duct lumen and the surrounding soft tissues [15].

Total number of cases of calculus disease was 25. Out of 25 cases, 19 patients had both GB and CBD calculus, six patients had only CBD calculus. The accuracy for diagnosing GB calculus by USG and MRCP was 100%, that for CBD calculus by USG was 98.3% and by MRCP was 100%. One case of distal CBD calculus was not diagnosed on USG, this may be due to very small size (4 mm) and soft morphology of calculus. Since the data in present study, shows that MRCP and USG have the same diagnostic potential in choledocholithiasis, the purpose of USG is to select candidates for therapeutic ERCP without proceeding to MRCP. In authors' opinion, however, MRCP should only be applied for the correction of possible false negatives from USG. The MRCP, for its high diagnostic value, is necessary in patients showing equivocal clinical and laboratory findings and negative USG prior to performing ERCP and/or Percutaneous Transhepatic Cholangiography (PTC), which are invasive procedures.

The accuracy for diagnosing choledochal cyst by USG and MRCP were 100%. This is almost similar to the observations in the study conducted by Bhatt CJ et al., [16].

In authors' US study of benign stenosis, the authors obtained fair accuracy (95.1%), high specificity (98.2%) and low sensitivity (60%) The high specificity was attributable to the capability of USG to detect true negatives in benign stenosis, thus, showing the cause of the obstruction by calculi or malignant stenosis. The MRCP performed better in detecting true positives. The results of present study for diagnosing benign stricture are in accordance with that observed by Singh A et al., (2014) and Hekimoglu K et al., (2008) but were much higher than Ferrari FS et al., (2005) [13,17,18].

The GB mass in the present study was most common malignant cause of biliary tract obstruction. Out of total ten cases of GB mass one case was reported false negative as cholecystitis with stricture. On the other hand MRCP diagnosed all the case of carcinoma of GB accurately. The accuracy for diagnosing GB mass by USG and MRCP was 98.3% and 100%, respectively. This is almost similar to the observations in the study conducted by Bhatt CJ et al., [16].

Cholangiocarcinoma was second most common cause of malignant lesion observed in our study. It is an intrahepatic mass with irregular borders and satellite nodules. It appears as hypo on T1W images and hyperintense on T2W images. In the present study, the accuracy for diagnosing cholangiocarcinoma was 100% on both USG and MRCP. The results of present study, were closely corresponding to results of Singh A et al., (2014) and Ferrari FS et al., (2005) [13,18].

Periampullary carcinoma appeared as a hypointense on T1W and variable signal intensity on T2W images. Marked and abrupt dilatation of distal bile duct and pancreatic duct and with absence of stone was diagnosed as periampullary carcinoma. USG diagnosed all the 8 cases of periampullary carcinoma with no false positive case (accuracy 100%). On MRCP, 8 cases were true positive (accuracy 100%). The present data on MRCP can be compared with those reported on malignant stenosis by Singh A et al., (2014), Bhatt CJ et al., Arslan A et al., (sensitivity of 88.6% and a specificity of 94.1%) and slightly lower than those by Little AF et al., (diagnostic accuracy, sensitivity and specificity of 97%, 93% and 100% respectively), Lomas DJ et al., (sensitivity of 100% and specificity of 98%) and Hussein FM et al., (sensitivity and specificity of 100%) [13,16,19-22].

In the present study, only one patient had pancreatic carcinoma. The masses usually appear nearly isointense or hypointense on T1 and variable signal intensity on T2 weighted images three segments (proximal and distal segments of the bile duct, and main pancreatic duct) were depicted in carcinoma of the pancreas (Three segment sign). In the present study, USG was 100% accurate in detecting hilar and suprapancreatic obstructions, whereas, MRCP was 100% diagnostic, which is almost similar to the results observed by Singh A et al., and Lopera JE et al., [13,23].

### Limitation(s)

The low sensitivity figures of benign stenosis by USG are to be related to intrinsic limitations of the methodology, which, though showing the indirect signs of stenosis, does not allow for optimal visualisation of the distal CBD and the ampullary region, which is where benign stenosis are often localised.

### CONCLUSION(S)

The high sensitivity and diagnostic accuracy of USG in the present study is presumed to be derived from improvement in technology and operator experience. The MRCP is required only for completion of malignant stenosis staging. If the suspicion posed by clinical and laboratory findings are not confirmed by USG, the diagnosis must be achieved with the aid of MRCP.

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### PARTICULARS OF CONTRIBUTORS:

1. Assistant Professor, Department of Radiodiagnosis, People's College of Medical Science and Research Centre, Bhopal, Madhya Pradesh, India.
2. Associate Professor, Department of Radiodiagnosis, People's College of Medical Science and Research Centre, Bhopal, Madhya Pradesh, India.
3. Associate Professor, Department of Radiodiagnosis, People's College of Medical Science and Research Centre, Bhopal, Madhya Pradesh, India.

### NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Abhinesh Saraf,  
C-17, New Minal Residency, Bhopal, Madhya Pradesh, India.  
E-mail: abhinesh.saraf@gmail.com

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